SUMMER TEMPERATURES IN THE UNITED STATES

ARNOLD COURT

Office of The Quartermaster General, [1] [2] Washington, D. C.

[Manuscript received August 21, 1951]

ABSTRACT

Percentage frequencies of hourly temperatures above certain values from 40° to 110° F., by 5° intervals, are presented for 102 places in the United States in summer (June-July-August). The frequencies are based on hourly readings, generally at airways weather stations, during five years 1935–1939. Since average summer temperatures during this period were somewhat warmer than long-term "normals," the resulting tabulation is considered applicable to a "typical warm summer" such that only about 15 summers per century would be warmer. The percentages are presented in a table, and those for temperatures above 85° (30° C. or higher) are shown on a map to indicate the regions where refrigerated storage is desirable for chocolate candy, which turns white ("graying" or "blooming") as soon as its temperature exceeds 85°.

INTRODUCTION

Summer temperatures in the United States, when described by the percent of hours expected to be above various values, can be used in quantitative estimates for such purposes as air conditioning and refrigeration not possible from the generally available averages and extremes. To obtain these percentage frequencies, hourly temperatures during five years in the United States were summarized and analyzed.

The basic observations were the hourly readings of wet and dry thermometers at airways weather stations, during 5 years (1935–39). These were tabulated and summarized by the Weather Bureau, through the Works Progress Administration, at the request of the American Society of Heating and Ventilating Engineers. Six separate summaries were made: air temperature, dew point, wet-bulb temperature, and correlations of air temperature with wet-bulb depression and of air temperature with wind speed. These six summaries are available on microfilm,[3] and portions of them have been used extensively in various studies [1, 2, 3]. Only the first of these summaries, for air temperatures, was used for the present study.

Of the 117 stations in the original tabulation, 15 were discarded because they had less than 10,000 of the 11,040 hourly observations possible during the 5 summers. The 102 remaining stations are generally distributed along the civil airways which had scheduled night-time flights during that period, so that the coverage of the United States is not uniform. From the original tabulation, which gave the frequencies of observations by each hour of the day for each month, the monthly totals for the three summer months were combined and reduced to percentages, shown in table 1.

DISCUSSION

Table 1 gives the percent of all hours during June, July, and August, 1935–39, on which temperatures at each of the 102 places, in 40 states and the District of Columbia, were above certain values from 40° to 110° F., by 5° intervals. The five summers, 1935–39, the period of observations on which the table is based, were slightly warmer than the long-term averages for the United States. For each of the 102 stations, average summer temperatures for those five years were computed and compared with the "normals" for the same places, as shown in the Weather Bureau's latest (1950) Climatological Data for the United States, by Sections. For a few of the places, such as El Morro, N. Mex., and Arlington, Oreg., detailed climatic data were not available, and the comparision was based on nearby stations with long records.

For the United States as a whole, a separate study not yet completed, indicates that the standard deviations of mean monthly temperatures in summer vary from nearly 4° in the Great Plains to less than 1° along the southern coasts, with the nationwide average about 2°. Since average monthly temperatures in general follow the "normal" distribution of statistical theory, it appears that for the United States as a whole about two summers out of three have average temperatures within 2° of the long-term averages, and only about one summer in six is more than 2° warmer than those averages.

During 1935–39, the average of summer temperatures at the 102 places for which frequencies are shown in table 1 was 1.8° warmer than the long-term "normals."

[1] Published with the approval, but not necessarily the endorsement, of the Department of the Army.

[2] Present address: 1520½ Spruce St., Berkeley 9, Calif.

[3] Information concerning these tabulations and their availability may be secured by addressing Chief, U. S. Weather Bureau, Washington 25 D. C., Attention: Climatological Services Division.

TABLE 1.—*Percent of hours in summer (June-July-August) with temperature above indicated values. (First column shows total number of hourly readings, 1935–39 inclusive, used)*

		40°	45°	50°	55°	60°	65°	70°	75°	80°	85°	90°	95°	100°	105°	110°
Alabama																
Birmingham	11,038				99.9	99.2	97.0	86.3	58.0	38.1	21.9	8.3	1.7	1.7	0.1	
Mobile	11,036					99.9	99.7	96.1	73.1	42.5	22.4	5.4	0.7	(*)		
Arizona																
Kingman	11,029		99.9	99.6	98.7	96.5	92.2	80.8	65.8	50.8	36.6	23.2	9.7	.1		
Phoenix	11,032				(#)	99.6	98.3	94.3	87.8	75.1	59.8	46.0	31.9	17.8	5.9	0.6
Tucson	10,993			(#)	99.9	99.6	98.2	93.1	88.5	61.2	45.8	31.0	17.0	4.6	.3	
Winslow	11,014		99.8	99.1	97.1	92.2	81.6	65.1	50.3	36.6	23.2	10.8	2.6	.1		
Arkansas																
Little Rock	10,825				(#)	99.6	97.7	89.5	66.0	45.7	30.3	16.3	5.5	.7	(*)	
California																
Bakersfield	11,019			(#)	99.7	98.4	93.6	83.7	71.1	57.3	43.2	30.2	18.8	8.3	1.7	(*)
Burbank	11,036		(#)	99.6	96.4	79.9	58.6	42.3	30.0	18.6	9.4	3.7	1.1	.2	(*)	
Daggett	11,037				99.8	98.9	96.0	89.4	77.8	63.0	49.3	36.1	23.4	10.2	2.0	.1
Fresno	11,029			(#)	99.5	95.0	85.7	72.1	58.6	46.2	35.3	24.9	15.4	6.1	1.3	(*)
Oakland	11,016		(#)	99.0	85.9	48.5	26.3	10.1	4.1	1.6	.1					
Redding	11,040			(#)	99.1	96.5	91.3	81.2	66.2	49.7	35.8	22.5	11.2	3.6	.7	.1
San Diego	11,038				99.9	95.3	64.9	25.0	6.3	.9	.2					
Williams	11,036		(#)	99.6	95.9	87.0	75.8	64.3	53.8	43.4	33.4	23.4	14.1	5.8	1.6	.2
Colorado																
Denver	11,040	99.8	99.2	97.2	92.9	82.5	65.7	49.0	36.1	24.4	14.4	5.7	1.1	.1		
Pueblo	11,012	(#)	99.7	98.9	95.9	87.8	73.7	58.9	45.0	32.9	22.1	11.5	3.0	.1		
Connecticut																
Hartford	10,813	(#)	99.8	98.6	95.3	85.1	70.0	50.9	30.9	16.2	6.2	1.4	.2			
Florida																
Jacksonville	11,040						99.5	95.2	67.9	41.7	25.7	10.6	1.8	.1		
Miami	11,034						99.8	96.5	73.1	43.5	20.6	.8				
Titusville	11,025						99.8	94.5	64.2	38.5	20.1	2.5	.1			
Georgia																
Atlanta	11,028				(#)	99.5	97.4	84.4	55.1	35.4	19.8	7.2	1.2	(*)		
Idaho																
Boise	10,940	99.7	98.4	94.3	86.4	74.7	62.1	50.2	38.9	28.2	18.7	9.8	3.0	.6	(*)	
Burley	10,992	99.4	97.0	91.2	82.3	69.6	55.7	42.8	30.7	20.8	11.7	4.1	.7	(*)		
Idaho Falls	11,006	98.9	95.3	87.9	76.5	62.4	48.5	36.0	24.9	15.7	7.0	1.4	.1			
Illinois																
Chicago	11,036		99.9	98.8	96.0	89.7	78.1	59.1	38.8	22.4	11.5	4.6	1.1	.3	(*)	
Moline	11,038		99.9	98.8	96.5	90.8	80.6	64.2	44.8	28.8	16.0	6.7	2.3	.8	.2	
Indiana																
Indianapolis	11,006			99.8	97.8	93.2	83.2	64.7	42.7	25.4	11.1	3.3	1.2	.4	(*)	
Iowa																
Des Moines	11,038		99.9	99.4	97.4	92.4	82.1	65.6	46.2	28.7	15.9	7.2	2.5	.8	.1	(*)
Kansas																
Wichita	11,026		(#)	99.9	99.1	97.2	92.6	81.4	64.3	46.7	32.0	19.8	10.0	3.1	.8	.1
Kentucky																
Louisville	11,036			99.9	99.2	96.1	89.1	74.4	51.1	32.6	16.4	5.5	1.5	.3	(*)	
Louisiana																
New Orleans	11,036							99.5	87.0	50.0	25.4	7.4	.6	(*)		
Shreveport	11,040					(#)	99.5	96.1	77.7	52.6	34.5	19.4	6.2	.7	(*)	
Maryland																
Baltimore	11,025		(#)	(#)	99.8	97.9	91.0	74.9	50.8	27.8	13.3	3.5	.6	.1		
Massachusetts																
Boston	11,039			99.9	97.7	86.8	68.5	44.7	23.2	11.0	4.1	1.0	.1			
Michigan																
Detroit	11,039		(#)	99.1	95.9	88.4	75.2	55.0	33.9	17.8	6.7	1.9	.6	.2		
Minnesota																
St. Paul	11,038	(#)	99.5	98.4	95.5	87.7	74.0	56.1	37.8	22.1	10.7	3.6	1.1	.4	.1	(*)
Missouri																
Kansas City	11,015			99.9	99.4	97.4	92.4	82.5	66.4	48.9	31.8	18.9	9.5	3.2	.7	
St. Louis	11,039			(#)	99.4	96.9	91.2	78.2	58.6	39.4	23.1	10.8	4.1	1.4	.1	
Springfield	11,000			99.9	99.0	96.3	89.1	71.5	50.4	33.7	20.7	10.1	3.3	.7	(*)	
Montana																
Billings	11,040	99.8	98.7	94.6	87.2	75.4	59.6	44.5	31.1	20.0	11.4	5.1	1.5	.2		
Butte	11,025	95.1	87.6	75.3	61.3	47.9	36.3	25.6	16.8	8.3	2.6	.4	.1			
Nebraska																
North Platte	11,011	(#)	99.6	97.8	94.0	86.5	75.6	59.5	45.1	32.0	21.5	11.9	4.9	1.6	.2	
Omaha	11,031		(#)	99.6	98.0	94.5	86.6	73.4	55.8	38.1	23.6	12.8	5.4	1.7	.4	(*)
Nevada																
Elko	11,033	97.9	93.2	84.9	74.6	64.4	53.6	43.5	34.3	24.6	15.1	6.2	.7	(*)		
Reno	11,030	98.8	95.3	86.8	76.5	65.0	54.9	45.4	35.4	25.3	15.4	6.4	1.5	.1		
New Jersey																
Camden	11,013		(#)	99.9	99.5	95.7	85.3	67.8	43.9	25.5	12.2	3.6	.5	.1		
Newark	11,032		(#)	99.9	99.5	94.7	81.6	61.6	35.6	18.0	7.0	1.7	.3	.1		
New Mexico																
Albuquerque	11,037		(#)	99.6	98.5	94.2	81.0	62.8	47.4	33.0	20.3	7.9	1.2			
El Morro	11,032	98.3	95.3	89.4	78.3	61.8	49.2	37.3	24.2	10.3	1.9	(*)				
Rodeo	10,861			99.9	99.4	98.0	93.4	77.7	60.4	45.0	31.7	17.5	5.2	.3		
Tucumcari	11,033		(#)	99.9	99.2	96.2	86.5	69.8	53.0	39.3	27.2	15.4	4.8	.4	(*)	

See footnote at end of table.

TABLE 1.—*Percent of hours in summer (June-July-August) with temperature above indicated values. (First column shows total number of hourly readings, 1935–39 inclusive, used)*—Continued

		40°	45°	50°	55°	60°	65°	70°	75°	80°	85°	90°	95°	100°	105°	110°
New York																
Albany	11,040		99.9	99.1	95.7	85.8	69.3	48.8	28.9	15.4	6.4	1.4	0.1	(*)		
Buffalo	11,039	(#)	99.8	98.4	92.6	81.7	66.0	45.1	26.2	11.6	3.4	.4				
Rochester	11,028		99.8	98.5	92.5	82.8	67.3	46.5	29.1	15.5	6.4	1.4	.3	0.1		
Syracuse	11,028		99.8	98.4	93.1	83.3	69.2	50.6	31.8	16.7	6.8	1.3	.3	.1		
North Carolina																
Charlotte	11,039				(#)	98.9	95.5	79.9	51.1	32.8	18.2	6.6	1.4	.1		
Greensboro	11,024			99.9	99.3	97.4	90.4	69.1	43.8	27.2	12.7	3.0	.3			
North Dakota																
Bismarck	10,084	99.6	98.1	94.8	88.4	77.7	64.2	49.6	36.3	24.4	14.7	7.4	3.4	1.3	0.4	0.1
Fargo	11,003	99.1	98.0	95.4	89.3	78.3	64.0	48.2	34.0	21.8	11.6	5.3	1.9	.7	.2	.1
Ohio																
Akron	11,038		99.8	99.0	95.0	87.1	74.1	52.4	32.0	17.4	6.4	1.3	.4	(*)		
Cincinnati	11,039		(#)	99.6	97.9	92.9	84.4	68.8	47.1	30.3	17.7	6.5	1.7	.5	.1	
Cleveland	11,040		99.8	98.8	95.5	87.9	75.9	55.8	35.7	20.5	9.3	2.6	.7	.3	(*)	
Columbus	11,039		99.9	99.3	96.9	90.8	79.8	60.0	38.1	22.1	10.1	2.2	.6	.2		
Toledo	11,039	(#)	99.8	98.9	98.7	88.0	74.3	54.4	34.8	19.9	9.0	2.9	.8	.2	(*)	
Oklahoma																
Ardmore	10,906				(#)	99.8	98.2	91.4	71.9	52.4	36.3	22.5	10.1	2.0	.3	
Oklahoma City	11,033				99.9	94.4	96.9	88.4	71.1	50.1	34.0	19.7	8.6	1.8	.4	(*)
Tulsa	10,951			(#)	99.8	99.1	95.8	86.6	68.6	48.5	31.9	18.3	7.4	2.0	.3	
Waynoka	11,040			99.9	99.5	97.9	93.9	84.5	71.0	54.2	38.3	25.9	15.8	6.7	1.5	.2
Oregon																
Arlington	10,617		99.9	98.5	93.4	82.3	67.3	51.2	36.9	24.7	15.2	7.7	3.0	1.0	.2	(*)
Baker	11,016	98.5	94.2	86.1	73.8	59.8	46.6	34.3	24.0	14.8	7.5	2.5	.5	(*)		
Eugene	11,036	99.9	98.3	91.5	76.2	56.9	41.6	28.9	18.2	10.0	4.4	1.6	.6	(*)		
Medford	11,040		99.2	96.1	87.1	72.7	58.2	44.2	32.6	22.5	14.0	6.6	2.4	.5	.1	
Portland	11,037		(#)	99.1	91.3	67.7	45.1	28.4	16.7	8.6	3.5	1.5	.5	(*)		
Pennsylvania																
Curwensville	11,033	(#)	99.2	95.9	88.1	74.6	50.6	30.1	15.5	5.1	.8	.2	(*)			
Erie	10,993	(#)	99.7	98.6	94.2	84.2	68.3	45.5	23.7	8.9	2.5	.4	(*)			
Harrisburg	11,032		(#)	99.9	98.6	93.5	82.3	65.0	41.7	24.3	11.1	3.4	.6	.1		
Sunbury	11,034		(#)	99.5	96.6	89.2	75.4	54.5	34.1	19.8	7.6	1.6	.2	(*)		
Pittsburgh	10,506			99.9	97.8	91.2	78.4	54.2	33.0	16.9	6.0	1.1	.2	(*)		
South Carolina																
Charleston	11,030				(#)	99.6	97.7	88.8	58.1	34.2	16.0	3.3	.5			
Tennessee																
Chattanooga	11,033			(#)	99.6	98.2	94.0	79.2	53.5	36.4	21.8	8.5	1.8	.2		
Memphis	11,026				99.9	99.3	96.8	88.8	67.9	45.3	28.6	13.6	4.3	.5		
Nashville	10,979			(#)	99.6	98.3	94.2	82.2	58.2	37.8	22.1	8.9	2.2	.3		
Texas																
Abilene	11,033					99.8	98.4	90.8	71.6	51.2	35.0	19.8	5.7	.5		
Amarillo	11,037		(#)	99.7	99.0	95.9	85.8	68.5	51.8	37.3	24.6	12.6	3.4	.3	(*)	
Dallas	11,039					(#)	99.5	96.9	84.7	60.4	41.0	24.8	10.6	1.9	.2	(*)
El Paso	11,039					99.8	97.6	85.0	66.7	48.4	32.8	17.2	4.6	.4		
Houston	11,028						99.9	97.8	71.6	44.5	27.6	8.5	.9	.1		
San Antonio	11,005						99.9	98.0	80.4	54.1	36.6	21.1	7.6	.5	(*)	
Wink	11,005					99.8	98.3	87.8	67.7	50.1	36.1	23.3	9.9	2.0	.2	
Utah																
Milford	10,956	99.6	99.1	97.1	92.4	82.9	68.1	54.2	41.9	31.1	19.9	8.5	1.6	.1		
Salt Lake City	11,033	99.9	99.2	97.1	93.6	87.0	76.2	60.5	45.3	32.2	19.9	9.4	2.4	.2		
Virginia																
Richmond	11,006		(#)	99.9	99.4	96.7	88.6	71.5	45.6	27.8	14.7	4.4	.5	.1		
Washington																
Ellensburg	10,289	99.6	97.5	91.4	78.9	62.7	46.6	32.2	21.5	13.0	6.3	2.4	.6	.1		
Seattle	11,038		99.8	97.4	82.3	55.7	35.7	19.1	8.8	3.3	.9	.1				
Spokane	11,040	99.9	99.0	94.0	83.6	68.7	54.1	40.2	28.5	18.5	10.0	4.5	1.3	.2		
Wisconsin																
La Crosse	11,032	99.8	99.2	97.4	93.1	84.7	71.4	53.8	35.8	21.3	9.8	3.0	1.0	.3	(*)	
Madison	11,007	(#)	99.7	98.7	95.8	88.4	73.7	53.2	32.7	16.9	6.4	2.0	.7	.2	(*)	
Milwaukee	11,007		99.6	96.9	91.1	80.5	63.3	40.3	22.3	10.6	4.0	1.3	.4	.1		
Wyoming																
Cheyenne	11,022	99.0	96.9	92.4	82.3	66.6	51.2	37.9	27.4	16.5	7.5	.6	.1			
Rock Springs	11,034	98.2	94.7	87.2	76.5	62.5	49.0	37.0	26.0	14.8	5.7	.8	(*)			
District of Columbia																
Washington	10,987			(#)	99.9	98.3	92.5	77.2	53.1	31.8	16.5	5.2	.7	.1	(*)	

Between 99.95 and 100.00 percent.
* Between 0.00 and 0.05 percent.

Only seven places were colder than "normal," and only nine as much as 4° warmer, most of them in the central Great Plains. Thus, since the 1935–39 data, as summarized in table 1, may be considered as generally representative of a warm summer, there would appear to be somewhat less than one chance in six that the percentages will be substantially higher than those given for any of the 102 places.

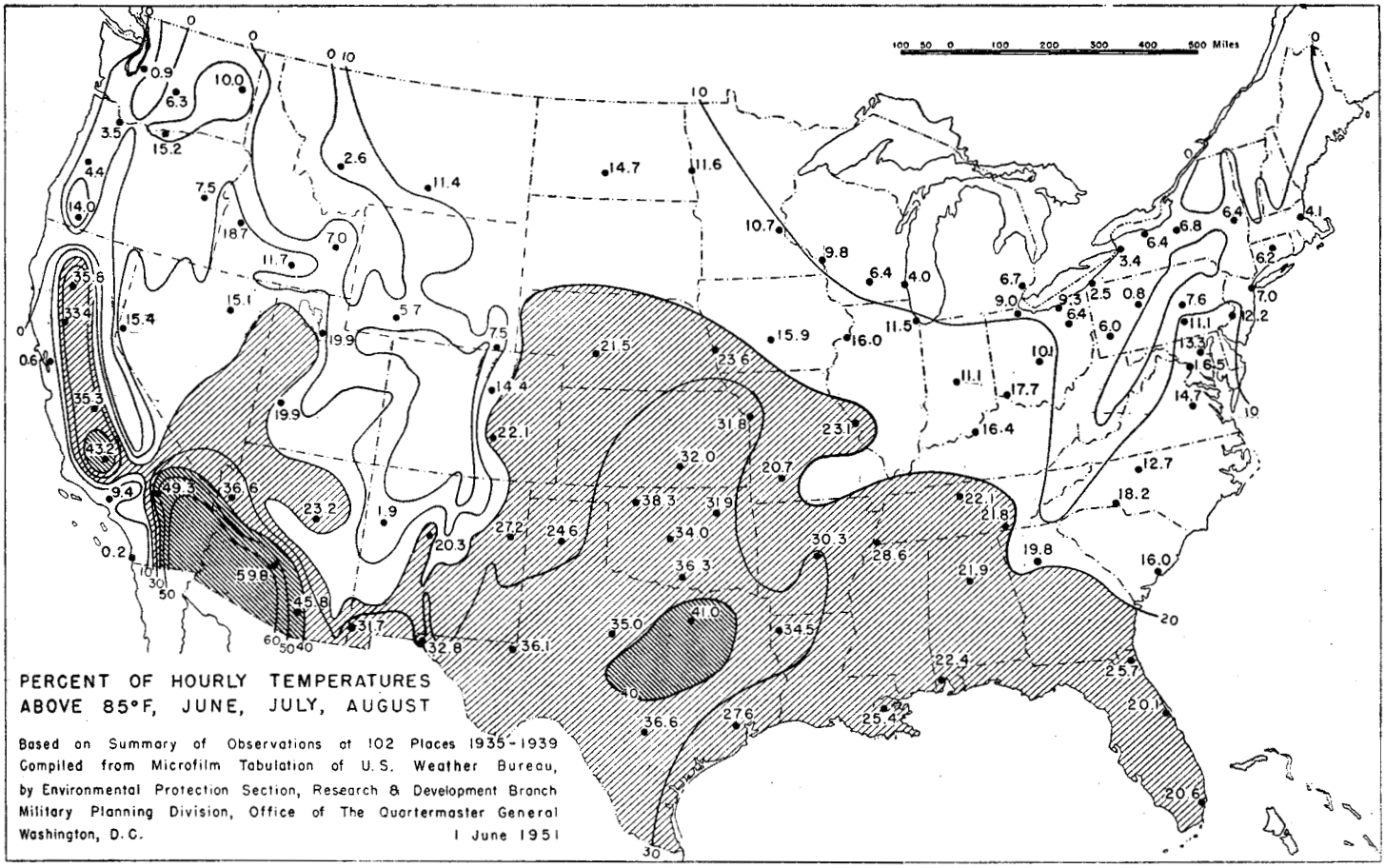

FIGURE 1.—Frequency of hourly temperatures above 85°F. in summer.

Only 15 of the 102 stations missed 40 or more hourly observations during the five summers, and eleven of these missed fewer than 223. The remaining four missed 413, 524, 751, and 956 observations, respectively. Most of the omissions were due to short cessations of operation, as when stations were moved, but may represent consistent skipping of one or more observations per day, usually at night, for one or more summers. Thus, for the few places with substantially less than the 11,040 observations of a perfect record, the percentages, because they are based on the actual number of observations and not the total possible, may indicate somewhat warmer conditions than would have been shown if all night-time hours were represented.

How well the hourly temperatures at each of the 102 stations represent the temperatures prevailing over the general area around the stations cannot be determined without detailed information on the locations of the stations and the conditions of thermometer exposure; such information has not been tabulated by the Weather Bureau. However, from the general conditions during those years at airways weather stations, at which nearly all of the observations were made, it appears that most of them (perhaps 80 percent) represent readings in regular thermometer shelters erected over sod or bare ground, on level terrain adjacent to airfields. Such readings should be representative of free air temperature, about five feet above the ground, over rather wide expanses, and thus generally applicable.

APPLICATION

This investigation, resulting in table 1, was the outgrowth of a simple problem in applied climatology: in what parts of the United States is refrigeration desirable to prevent deterioration of chocolate candy?

Detailed research at the Georgia Agricultural Experiment Station [4,5] has shown that "Temperatures from 85° to 95° cause graying or blooming of chocolates, even though exposure is only for a few hours." This undesirable change in the appearance of the candy "is a result of the melting of the layer of cocoa butter beneath the surface, causing it to penetrate the outer chocolate layer and become like 'cold grease' on the surface."

Since temperature above 85° F. appears, from this research, to be the critical factor causing the deterioration of chocolate candy, refrigerated cases to counteract such deterioration may be advisable in places where the candy temperature is likely to exceed this value on any substantial number of occasions. The temperature of candy

on display in a store, or in cardboard boxes on a shelf in the store or the adjacent storeroom, lags behind that of the surrounding air by perhaps an hour. Consequently, it is likely that unless the air temperature in the store exceeds 85° for at least an hour, the candy will not be affected by graying or blooming.

During warm weather, buildings not provided with artificial cooling usually are ventilated as much as possible, and the air inside the building is at least as warm as the outside air, as measured by standard meteorological procedures in a thermometer shelter five feet above the ground; in many buildings, especially those of a single story, the afternoon air temperature frequently exceeds that in a thermometer shelter.

To locate places where the air temperature (and thus that of candy) inside buildings is likely to be above 85°, the summertime frequencies of hourly temperatures above 85°, as shown in table 1, were plotted on a map (fig. 1). Isopleths were drawn for every 10 percent, considering not only the 102 stations themselves but the general topography, so that mountains are shown as having zero likelihood of temperatures above 85° although no observations in them are available.

RESULTS

During a typical warm summer (fewer than about 15 summers per century would be expected to be warmer), hourly temperatures exceed 85° about one-fifth of the time over nearly one-third of the United States. Two-fifths of all hourly readings are above this value in central Texas, central California, and the lowland desert area of California, Arizona, Nevada, and Utah.

On the other hand, less than one-tenth of all summer hours have temperatures above 85° along the Oregon-Washington coast, around the Great Lakes, and in the northeastern States; there is very little likelihood of such temperatures in the northern Rocky Mountains, the central Appalachians, and the mountains of northern New York and New England.

Temperatures above 85° occur in spring and autumn as well as in summer, but over most of the United States about four-fifths of the hours with such temperatures fall in the three summer months. Table 2 shows the number of hours during the five years with temperatures over 85° in summer, throughout the entire year, and the percent of such hours in summer, at 20 of the 100 places well-distributed over the United States.

At 14 of these 20, including such diverse places as Spokane, Detroit, El Paso, and Atlanta, the percentages are between 77 and 85, inclusive, and at all except two they are between 68 and 91. The two exceptions are Oakland (33%) and San Diego (16%), where oceanic influence causes more hours above 85° in early autumn than in summer (San Diego had 72 hours in five Septembers, 25 in five Octobers, only 20 in five entire summers).

Since summer is the principal season during which temperatures over 85° are likely, the percentages given in table 1 and figure 1 indicate the general likelihood of such temperatures during the entire year, except on the California coast where the annual total of such temperatures is negligible. Consequently the map shows the percent of time in summer during which refrigeration is required to prevent graying or blooming of chocolate candy in various areas of the United States, and in general the areas where such protection is required at some time during the year.

Whether refrigeration for chocolate candy should be provided in places expecting temperatures over 85° during 10 percent of the time in summer, or 20 percent, or 30 percent, depends on economic considerations, such as the cost of protection relative to possible loss. This map, however, provides the climatic basis for such a decision, and any other involving the same critical temperature.

OTHER USES

Other uses may be made of the map. For example, 85° is about the temperature (depending on humidity, ventilation, and radiation) at which human discomfort is first demonstrated by removal of coats, turning on of fans, and frequent trips to the water cooler. Until a more satisfactory index of such discomfort is developed, which would include humidity and air movement, and perhaps radiation, and climatic data are converted to it and tabulated, this map can serve as a rough index to the need for air conditioning or other means of alleviating the discomfort of hot weather.

Since the map shows the frequency of temperatures of 86° F. or over, which is exactly the same as 30° C. or over, it may be compared directly to similar maps prepared for

TABLE 2.—*Total hours during 5 years (1935–39) with temperatures over 85° F. in summer, throughout the year, and percent in summer*

	Summer	Year	%		Summer	Year	%
Salt Lake City, Utah	2,192	2404	91	Atlanta, Ga.	2,188	2,793	78
Syracuse, N. Y.	754	857	88	Waynoka, Okla.	4,227	5,395	78
Erie, Pa.	278	326	85	Louisville, Ky.	1,815	2,359	77
Spokane, Wash.	1,103	1,298	85	Medford, Oreg.	1,545	2,005	77
Madison, Wis.	704	848	83	Memphis, Tenn.	3,149	4,105	77
Omaha, Nebr.	2,602	3,154	83	Nashville, Tenn.	2,431	3,175	77
Detroit, Mich.	744	915	81	Fresno, Calif.	3,889	5,293	74
Kansas City, Mo.	3,504	4,359	80	Jacksonville, Fla.	2,838	4,180	68
El Paso, Tex.	3,624	4,593	79	Oakland, Calif.	63	191	33
Greensboro, N. C.	1,395	1,771	79	San Diego, Calif.	20	123	16

other countries using Centigrade temperatures. For other problems with other critical temperatures, analagous maps can be drawn from the data of table 1 of the percentage frequency of hourly temperatures in summer.

ACKNOWLEDGMENTS

Computation of the cumulative percentages of table 1 and plotting of figure 1 were done by Mrs. Vera Grove, statistician, from data cards which she had previously prepared from a copy of the original microfilmed tabulation. Annual values used in table 2 were furnished by Dr. Paul A. Siple. The 1935–1939 summer averages and their departures from "normal" were computed by Mr. O. S. Parmele, statistical clerk. Advice in drawing the percentage lines of figure 1 was given by Mr. Norman Sissenwine, meteorologist, and Drs. Peveril Meigs and Louis Peltier, geographers.

REFERENCES

1. C. A. Gosline, "The Role of the Meteorologist in a Large Company," *Bulletin of the American Meteorological Society*, vol. 30, April 1949, pp. 119–123.
2. Paul A. Siple, "American Climates," *Bulletin of the American Institute of Architects*, vol. 3, September 1949, pp. 15–36, and 14 succeeding numbers.
3. Arnold Court, "Temperature Frequencies in the United States," *Journal of Meteorology*, vol. 8, December 1951, pp. 367–380.
4. J. G. Woodroof and others, "Cold Stored Candies; Special Food Industries Report," *Food Industries*, vol. 22, August 1950, pp. 1356–1367.
5. J. G. Woodroof and H. H. Thompson, "What Refrigeration Does for Candies," *Refrigeration Engineering*, vol. 58, December 1950, pp. 1169–1172+. Discussion, vol. 59, January 1951, pp. 50–51.